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YIELD AND NUTRIENT UPTAKE BY SOYBEAN IN RESPONSE TO ENRICHED COMPOSTS UNDER VERTISOLS

ASHAY D SOUZA, P. W. DESHMUKH, S. M. BHOYAR, D. V. MALI & SHAMNA K

Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Maharashtra, India

ABSTRACT

Field experiment was conducted to study the effect of enriched composts like phosphocompost and nitrophospho-sulpho compost on yield and nutrient uptake by Soybean in Vertisol during kharif season of 2015-16 at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment comprised of eight treatment combinations executed in randomized block design with three replications. The results indicated highest grain and straw yield (27.90 and 43.67 q ha^{-1}) were recorded by the treatment of 100% P through nitrophospho -sulpho compost. Application of 100% P through Nitrophospho-sulpho compost recorded significantly the highest uptake of N (175.61 kg ha^{-1}), P (17.74 kg ha^{-1}), K (71.01 kg ha^{-1}) and S (32.10 kg ha^{-1}), followed by 100% P through Phospho compost. The study indicated application of enriched composts showed better yield, nutrient uptake and improved soil chemical properties.

KEYWORDS: Soybean, Enriched Composts & Vertisols and Yield

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Original Article

INTRODUCTION

Soybean (*Glycine max* L. Merrill) is known as Golden Bean of 20th century. It is second largest oilseed in India after groundnut. Soybean is an important grain legume crop and it is leading plant source of dietary protein worldwide. It can supply the much needed protein of superior quality of all the amino acids. Particularly Glycine, Tryptophan and Lysine. Soybean contains protein- 40%, carbohydrates- 30%, fibre-0.5%, lecithin- 0.5%, saponins- 4% and oil- 20%.

Vertisols are clay soils with unique properties. In India, they are commonly called black cotton soil. These soils have great potential for agricultural production and are economically important because of their productivity. Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and Karnataka accounts for about 36, 23, 12, 10 and 9 percent of India's total area under Vertisols, respectively.

Use of organic manures saves the environment and it includes use of enriched composts like phospho-compost, sulpho- compost, vermicompost, green manure to maintain the soil fertility and ensure balanced nutrient content in soil.

Phosphate application increases the protein content in Soybean seed (Kacha *et al.,*1990).Application of phosphorous to Soybean crop is must, because its seed contain nearly 35 -45% protein and 18 – 24% oil, therefore during pod filling stages phosphorous is transferred from leaves, branches and main stem to seed. Yield of oilseed crops can be increased by application of phospho-compost and nitrophospho-sulpho compost. Increase in application of phosphorous and sulphur in the soil increases the availability of phosphorous and sulphur from

native as well as applied sources and have both synergistic and antagonistic relationship. (Randhawa and Arora,1997)

The present investigation helped in monitoring effect of phospho-compost and nitrophospho-sulpho compost on yield and nutrient uptake by soybean. Combined application of manures and fertilizers improves soil health and productivity of crop. Use of organics like composts plays a role to improve the biological activity and soil health. It will be benefit to farmers, extension personnel and research workers to have combination of organics with in organics to obtain sustainable yield and maintain soil health for long time.

MATERIALS AND METHODS

The present investigation was undertaken at Research Farm of Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif season of 2016-17 entitled "Yield and nutrient uptake by soybean in response to enriched composts under vertisols". The experimental soil was developed on basaltic platue on plain land and classified under Vertisols. The morphological characteristics of soil are medium deep, clayey in texture. Rainfall received during crop growth period i.e 28 June to 21 October amounted to 832.9 mm in 45 rainy days as against the normal of 728.4 mm. The trail was conducted using randomized block design having eight treatments replicated thrice. The treatments details are presented in table 1.

Table 1: Experimental Treatment Details

Sl. No.	Treatment Details
T_1	Control
T_2	100% RDF
T_3	50% P through PC +Remaining RDF through chemical Fertilizers
T_4	25% P through NPS +Remaining RDF through chemical Fertilizers
T_5	50% P through NPS +Remaining RDF through chemical Fertilizers
T_6	50% P through NPS +Remaining RDF through chemical Fertilizers
T_7	100% P through PC
T_8	100% P through NPS

RDF-Recommended Dose of Fertilizer, PC - Phospho Compost, NPS – Nitro-phospho - Sulpho compost

The representative soil sample (0-15 cm) was collected from each plot of experimental area before sowing and after harvest of crop. The soil sample was air dried in shade and grinded using wooden pestle and mortar with care that concretions in the samples were not crushed and then passed through 2 mm sieve. The processed samples were well mixed and then stored in clean cloth bags with labels for subsequent analysis. The dried plant samples were collected at harvest of crop

The nitrogen, phosphorus, potassium applied in the form of Urea, Diammonium phosphate, Muriate of potash respectively and also in combination with organic manures i.e Phospho-Compost and Nitrophospho-Sulpho compost. Treatment wise basal dose of fertilizers were applied at the time of sowing. The enriched compost was applied 15 days before sowing of crop. The nutrient content of enriched composts i.e Phospho compost and nitrophospho-sulpho compost is presented in table 2.

Table 2: Nutrient Status of Enriched Composts

Organics	N	P	K	S	C:N
Phosphocompost	0.80	1.65	0.68	0.39	20.44
Table 2: Contd.,					
Nitro phospho Sulpho compost	1.85	1.76	0.92	1.58	19.30

The data obtained by various parameters were analyzed in RBD by using standard statistical method.(Panse and Sukhatme, 1985)

RESULTS AND DISCUSSIONS

Effect of Enriched Composts on Productivity of Soybean

Grainand straw yield of soybean: Soybean is a high yield crop rich in protein and oil content has very high nutrient requirement (Aulakh et al.1985). The soybean grain yield received by the various treatments is presented in table 3.The grain yield of soybean as influenced by application various treatments is ranged from lowest to highest between 21.43 to 27.90 q ha^{-1}. The significantly higher grain yield of soybean was recorded by the application of 100% P through NPS (27.90 q ha^{-1}), followed by the treatment of application of 100% P through NPS(27.83 q ha^{-1}),However the yield obtained by both this treatment were statistically at par.

The soybean grain yield reported by other treatments i.e 25% (24.58 and 25.36 q ha^{-1} respectively) and 50% P(25.14 and 26.13 q ha^{-1} respectively) through phospho compost and nitro phospho-sulpho compost in combination with chemical fertilizers were found to be statistically at par with each other.

The significantly lowest grain yield of soybean was noticed in the control treatment(21.43 q ha^{-1}) where no fertilizers were applied. The Similar trend was reported by Prabhakar and Deshmukh(2004)where the treatment with application of FYM and compost showed highest grain yield compared to without application of organic manures.

The straw yield of soybean as influenced by application different treatments are reported in Table 6.The straw yield of soybean was ranged from 32.15 to 43.67 q ha^{-1}.

Significantly highest straw yield of soybean was obtained in the treatment of application of 100% P through NPS (43.67q ha^{-1}) followed by treatment with application of 50% P through NPS (42.20 q ha^{-1}),However the yield obtained by both these treatments were statistically at par.

The soybean straw yield reported by other combination treatments i.e 25%(36.87 and 38.04 q ha^{-1}), 50% P (37.71 and 41.75 q ha^{-1}) through phospho compost and nitro phospho-sulpho compost along with chemical fertilizers were found to be statistically at par with each other

The Significantly lowest yield was recorded by the treatment where no fertilizer and no manure were applied (T_1).Similar finding were recorded by Shivkumar and Ahlawat (2008)where application of poultry and city compost showed highest straw yield compared to without application of same.

The higher soybean grain and straw yield received by the 100% application of both the enriched composts may be due to full compensation of required nutrients to the crop, as well as the mansoon season during 2016-17 was also satisfactory.

Table 3: Effect of Enriched Composts on Productivity of Soybean

	Treatments	**Yield (Q Ha^{-1})**	
		Grain	**Straw**
T_1	Control	21.43	32.15
T_2	100 % RDF	24.58	36.67
Table 3: Contd.,			
T_3	50% P through PC + Remaining through fertilizer	25.14	37.71

T_4	25%P through PC+ Remaining through fertilizer	24.58	36.87
T_5	50% P through NPS +Remaining through fertilizer	26.13	41.75
T_6	25% P through NPS+ Remaining through fertilizer	25.36	38.04
T_7	100% P through PC	27.83	42.20
T_8	100% P through NPS	27.90	43.67
	SE (m)±	1.25	1.93
	CD at 5 %	3.77	5.83

Effect of Enriched Composts on Uptake of Nutrients

Soybeans accumulate N, P, and K in pods and seed more than in the leaves and stems. Although P is especially important for early season root development, more than 60 percent ends up in the pods and seed. Demand for N and P is greatest as pod and seed development takes place. Nitrogen is needed for the high protein seed while P compounds deliver the energy needed for seed formation.

Table 4: Uptake of Nitrogen, Phosphorous, Potassium and Sulphur by Soybean as Influenced by Various Treatments

	Treatments	Nutrient Uptake (Kg Ha^{-1})			
		N	P	K	S
T_1	Control	128.95	11.67	49.09	14.57
T_2	100% RDF	163.18	15.29	57.68	18.86
T_3	50% P through PC + Remaining through fertilizer	158.45	15.99	59.82	20.23
T_4	25 % P through PC + Remaining through fertilizer	152.91	15.50	58.62	21.13
T_5	50 % P through NPS + Remaining through fertilizer	164.53	16.47	65.34	25.29
T_6	25 % P through NPS + Remaining through fertilizer	162.87	16.69	60.59	25.17
T_7	100 % P through PC	166.59	17.74	68.05	28.31
T_8	100 % P through NPS	175.61	19.04	71.01	32.10
	SE(m)±	8.44	1.05	3.12	1.25
	CD at 5 %	25.5	3.19	9.44	3.78

Nitrogen Uptake: Nitrogen uptake by soybean as affected by various treatment is presented in Table 4 which ranges from 128.95 to 175.61 kg ha^{-1}.It revealed that, application of 100% NPS recorded significantly highest uptake of N (175.61 kg ha^{-1}) followed by 100 % P through PC which is at par with each other.

However, the treatment which received the 50%, 25% P through PC and NPS were at par with each other. The lowest uptake of Nitrogen i.e.128.95 kg ha^{-1} was recorded by control treatment which was at par with other treatments. Similar trend was found by Talati (2004).

Phosphorus Uptake: Phosphorus uptake as affected by various treatments is presented in Table 5 which ranges from 11.67 to 19.04 kg ha^{-1}.It was observed that the application of 100% NPS recorded significantly highest grain uptake of Phosphorus (19.04 kg ha^{-1}), followed by 100 % P through NPS (T_7).and they were found at par with each other.

The grain uptake of phosphorous of application of 50% P,25% P through PC and NPS were found at par with each other. The lowest uptake of phosphorus 11.67 kg ha^{-1} was recorded by control treatment. It was found on par with 100% NPK. It was observed that combine application of organic and inorganic help to improve uptake of phosphorus. (Reddy 1998).

Potassium Uptake: Potassium uptake as affected by various treatments is shown in Table 5 Potassium uptake was ranged from 49.09 to 71.01 kg ha^{-1}.It revealed that, application of 100% NPS recorded significantly highest uptake of K (71.01 kg ha^{-1}), followed by the treatment where 100% P through NPS (T_7) which was at par with each other and with

50% P through NPS+ remaining through chemical fertilizers. Application of 50% P through PC, 25% P through PC and NPS were found to be at par with each other. It had shown the integrated nutrient management benefits in case of yield and nutrient uptake. The lowest uptake of potassium i.e.49.09 kg ha^{-1} was recorded by control treatment which was at par with 100% NPK. Similar trend found by Bharambe and Tomar (2004).

Sulphur Uptake: Sulphuruptake as affected by various treatments in the plant is presented in Table 8 which was ranged from 14.57 to 32.10 kg ha^{-1}.It can be stated that application of 100% NPS recorded significantly highest uptake of Sulphur (32.10 kg ha^{-1}) followed by the treatment 100 % P through PC which was at par with each other.

However, the lowest uptake of Sulphur i.e.14.57 kg ha^{-1} was recorded by control treatment which was on par with all other treatments i.e T_2, T_3, T_4,T_5, T_6. Similar trend was observed by Jeevan Rao and Rama Lakshmi(2009).

Soil Chemical Properties after the Harvest of Soybean

Effect of Enriched Composts on Soil pH, Electrical Conductivity and Organic Carbon Content after Harvest of Soybean

Organic manures after their addition to soil undergo decomposition by the action of soil microorganisms. During such biological degradation, organic acids are formed which held to lower down the soil pH and EC. Similarly, the chemical fertilizers like nitrogenous, which are acidic in nature lower the pH and EC. Addition of organics like composts and FYM adds the carbon source to soil hence increases the organic carbon levels

Effect of enriched composts on soil pH: The pH of experimental soil as influenced by the various treatments after crop harvest is shown in table 5 which ranged from 8.17 to 8.36. The lowest pH i.e 8.17 and 8.21 was observed with treatment which received 100% dose through organic manure i.e Nitrophospho-sulpho compost and 25 % P through PC and NPS(T_8, T_4 andT_6) respectively. Numerically increased pH were recorded with 50% P through PC and 100% RDF. However, there were no significant changes noted in pH of soil after harvest of crop.

The slight change in pH with the application of organic sources such as Phospho- compost and Nitrophospho-sulpho compost were noted. The similar findings are inconformity with the results obtained by More and Hangarge (2003).

Effect on Electrical Conductivity: The effect of various treatments on Electrical Conductivity of soil is presented in Table 5. The Electrical Conductivity varied from lowest to highest values i.e 0.28 to 0.30 dSm^{-1}. The lowest Electrical Conductivity was 0.28 dSm^{-1} observed with application of 100% P through NPS and in treatment with 50% P through PC, 25% P through NPS with remaining RDF through chemical fertilizers. There were no significant changes noted in all treatment after harvest of crop. Similarly application of 50% compost showed lowest EC compared to other treatments observed by Halemani *et al.* (2004).

Effect on soil Organic Carbon content: The organic carbon content in soil is reported in Table 5. The organic carbon content after harvest of crop ranged from 5.45 to 6.74 g kg^{-1}. The significantly highest soil organic carbon content of 6.74 g kg^{-1} was recorded in treatment of 100% P through nitrophospho sulpho compost followed by application of 100% P through Phospho compost (6.67 g kg^{-1}). The soil organic carbon in the treatment with 100% RDF were also recorded to be 6.40 g kg^{-1} may be due to addition of more root biomass.

However, the application of both the compost in the tune of 25% and 50% in combination with inorganic fertilizer resulted in increased soil organic carbon content followed by 100% NPS (6.47(T_4), 6.56(T_6), 6.40 (T_3) and 6.53 (T_5) g kg^{-1})

treatment. They were statistically at par with other. Significantly lowest soil organic carbon content of 5.33 g ha $^{-1}$ was reported by control treatment. The increase in organic carbon content might be due to addition of organic matter through composts in both the treatments. The addition of organic manure in the form of both the composts showed increase in organic carbon content after harvest of crop. Lowest organic carbon content recorded in the control treatment. Similar trend of increasing organic carbon content by the application of organic manure were reported by Geetakumari (2011).

Table 5: Effect of Different Treatments on pH, Electrical Conductivity and Organic Carbon Content of Soil after Harvest of Soybean

	Treatments	pH (1:2.5)	EC (dSm^{-1})	Organic Carbon ($g\ Kg^{-1}$)
T_1	Control	8.29	0.30	5.45
T_2	100% RDF	8.35	0.30	6.40
T_3	50% P through PC + Remaining through fertilizer	8.36	0.28	6.40
T_4	25 % P through PC + Remaining through fertilizer	8.21	0.30	6.47
T_5	50 % P through NPS + Remaining through fertilizer	8.24	0.30	6.53
T_6	25 % P through NPS + Remaining through fertilizer	8.21	0.28	6.56
T_7	100 % P through PC	8.22	0.29	6.67
T_8	100 % P through NPS	8.17	0.28	6.74
	SE(m)±	**0.05**	**0.007**	**0.079**
	CD at 5 %	**NS**	**NS**	**0.23**

Initial status: pH- 8.2 EC - 0.27 dSm^{-1} Organic carbon - 6.30 g kg^{-1}

Micronutrient Status of Soil

Available Zinc (Zn): The status of available zinc after harvest of soybean is depicted in table 6 which ranged from 0.64 to 1.16 mg kg^{-1}.The significantly highest available zinc status was recorded in the treatment of application of 100% P through NPS i.e 1.16 mg kg^{-1}.followed by the application of 100% P through PC (1.14 mg kg^{-1}).However, available zinc content recorded by these treatments were statistically at par.

The available zinc status recorded by the treatment of application of 25% to 50% PC and NPS in combination with fertilizer were found at par with each other. The significantly lowest available zinc was recorded in the control treatment. The increase in zinc content may be due to use of organic manures in the form of both the compost. The similar trend was recorded by Babhulkar (2000).

Available Copper (Cu): The available copper as influenced by various treatments ranged from 1.64 to 2.07 mg kg^{-1}. The highest available copper was recorded with 100% P through NPS followed by 100% P through PC. There was numerical increase in available copper content were recorded in all the treatments where only organics and the combination of organic and inorganic were followed. However statistically there were no significant increase were recorded by all the treatments.

Available Iron (Fe) :The available iron content of soil ranged from 14.42 to 17.05 mg kg^{-1}.The significant highest available iron (17.05 mg kg^{-1}) was recorded by the treatment 100% P through NPS followed by 100% P through PC. The available iron content in all other treatment was found at par with each other. The lowest content of iron was reported in control treatment. Addition of organic manure along with chemical fertilizer has beneficial effect in increasing iron content of soil, the similar result were also reported by Hedge (2000).

Available Manganese (Mn)

The available manganese as influenced by various treatments ranged from 4.34 to 6.30 mg kg^{-1}. The highest available Manganese was recorded with application of 100% P through PC followed by 100% P through PC. There were numerically increased in available manganese content were recorded in all the treatments where only organic and the combination of organic and inorganic were followed. However statistically there were no significant increase were recorded by all the treatments.

Table 6: Effect of Various Treatments on Micronutrient Status after Harvest of Soybean

	Treatments	Zn (mg Kg^{-1})	Fe (mg Kg^{-1})	Cu (mg Kg^{-1})	Mn (mg $Kg^{-1)}$
T_1	Control	0.64	14.42	1.64	4.34
T_2	100% RDF	0.72	15.96	1.84	5.83
T_3	50% P through PC + Remaining through fertilizer	0.82	15.72	1.87	4.87
T_4	25 % P through PC + Remaining through fertilizer	0.95	14.87	1.89	5.06
T_5	50 % P through NPS + Remaining through fertilizer	1.01	14.78	1.95	5.65
T_6	25 % P through NPS + Remaining through fertilizer	1.06	16.27	1.95	5.86
T_7	100 % P through PC	1.14	16.35	2.03	6.24
T_8	100 % P through NPS	1.16	17.05	2.07	6.30
	SE(m)±	0.015	0.24	0.023	0.018
	CD at 5 %	0.048	0.73	0.068	0.056

Initial status: Zn – 0.73 mg kg^{-1}, Fe -13.45 mg kg^{-1}, Mn – 4.32 mg kg^{-1}, Cu – 1.84 mg kg^{-1}.

CONCLUSIONS

From the above experiment, it can be concluded that the application of organics in the form of enriched composts i.e Phospho compost and Nitro phospho-sulpho compost on basis of 100% dose of phosphorous enhanced the soybean grain and straw yield, nutrient uptake and soil chemical properties and micronutrient status. However application of 25% and 50% of dose of phosphorous by enriched composts along with remaining dose through chemical fertilizers also increased the Soybean grain and straw yield, soil chemical properties thus maintaining good soil

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